

No * 7857.53



172-12



CITY OF BOSTON.



ANNUAL REPORT

OF THE

CITY ENGINEER

FOR THE YEAR 1880.

OFFICE OF THE CITY ENGINEER, CITY HALL,
BOSTON, February 1, 1881.

To the Honorable City Council:—

In compliance with the sixth section of the ordinance relating to the Engineer's Department, the following report of the expenses and operations of the department for the year 1880 is respectfully submitted.

The duties of the City Engineer may be classified under the following heads:—

A. — Those pertaining to the City Engineer's Department proper, which consist in the superintendence of the filling of new streets and of districts, in the care and maintenance of bridges, in designing and superintending the construction of new bridges, retaining-walls, city wharves, etc., and in miscellaneous work called for by committees of the City Council. (City Engineer's Department.)

B. — Superintendence of the Sudbury River, Cochituate, and Mystic Water Works, including charge of new constructions for these works. (Water Works.)

C. — Charge of the building of a new system of works for bringing an additional supply of water from Sudbury River. (Additional Supply.)

D. — Charge of the construction of a system of intercepting and outlet sewers. (Improved Sewerage.)

E. — Charge of the engineering work in connection with the Back Bay and other proposed parks. (Parks.)

The expenses incurred under the heads C. and D. are paid wholly from special appropriations; one under the charge of the Water Board, the other under the charge of the Joint Special Committee on Improved Sewerage.

(A.) — CITY ENGINEER'S DEPARTMENT.

The following is a statement of engineering expenses from January 1, 1880, to January 1, 1881: —

Amount expended from department appropriation for 1879-80	\$6,765 54
Amount expended from department appropriation for 1880-81	19,276 23
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Total expended from department appropriations	\$26,041 77
Amount expended from special and other appropriations	2,074 60
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Total	\$28,116 37

Condition of department appropriation: —

Amount of appropriation for financial year 1880-81	\$26,000 00
Amount expended to January 1, 1881	19,276 23
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Unexpended balance, January 1, 1881	\$6,723 77

From special and other appropriations: —

New main Cochituate Water Works.	
Pay-rolls	\$807 50
Chelsea Bridge.	
Pay-rolls and incidentals	575 50
Broadway extension.	
Pay-rolls and incidentals	691 60
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Total	\$2,074 60

CLASSIFICATION OF EXPENSES.

Salaries of City Engineer, assistants, draughts-	
men, transitmen, levellers, rodmen, etc. .	\$23,411 74
Engineering instruments and repairs of same .	144 35
Drawing paper and materials	245 30
Stationery and printing stock	187 32
Reference books, maps, photographs, and frames,	218 36
Printing and binding	74 46
Travelling expenses, including horse-keeping,	
etc.	645 18
Horse and new carriage	592 50
Incidental expenses and small supplies . . .	303 41
"Blue Process" printing and materials . . .	132 65
Committee expenses	86 50
Total	<hr/> \$26,041 77

The number of persons employed and paid from the department appropriation was, on the first of January, 1880 (including the City Engineer), 18. The present number is 22. The operations of the department for the year, together with such general information relating to the various works and structures, finished and in progress, as is thought to be of interest, are given in the following statements:—

BRIDGES.

The largest portion of the work done on the tide-water and inland bridges, during the year, has been in the way of repairs.

The city's portion, with the exception of the draw and its foundations, of the Chelsea bridge over the main channel of the Mystic river, has been entirely rebuilt.

Two new street bridges are in process of construction,—the bridge over the Boston and Albany Railroad on the extension of Broadway, and the Beacon-street bridge over the Park water-way. In the Back-Bay park the foundations are being put in for an arched bridge on Boylston street, over the Park pond.

The ordinary repairs of the bridges in charge of the Committee on Bridges have been made by day's labor, under the same system adopted by the committee of last year. Mr. S. S. Lewis has been the superintendent of the work, receiving for this service, and for furnishing a team and transportation for his men, \$100 per month, and \$2.00

per day for labor furnished. His work has comprised all the carpentering, painting, and odd jobbing required on the bridges. Machinists' and blacksmiths' work, pile-driving, stone-work, paving, calking, and concrete-laying have been done by day's labor, but by agreement after competition.

The spruce lumber required for repairs has been furnished by Mr. John W. Leatherbee, the lowest bidder, and the contractor for several past years. He has furnished 245,880 feet B.M., for \$13.90 per M., under his contract of 1880, and 3,279 feet B.M., for \$11.90 per M., under his contract of 1879. The other kinds of lumber required have been bought of the lowest bidders under competition, and in the open market.

The total cost of repairs made under the direction of this department on the tide-water bridges has been \$25,565.02.

Repairs have been made under the supervision of this department upon many of the inland bridges, at the request of the Superintendent of Streets. This work has been done by day's labor, and with materials purchased in the open market. The total cost of these repairs has been \$2,501.66.

The usual annual examination (required by Section 5 of the ordinance relating to the Engineer's Department) of all bridges within the city limits open to team and foot travel has been made; and the results of this examination, in regard to the condition of the bridges as to safety and need of renewal or repairs, are given in the following pages.

The following is a list of the bridges inspected. The number is one greater than last year, owing to the two portions of Chelsea bridge, which now have about a quarter of a mile of solid street between them, being considered as separate bridges.

Those marked with an asterisk are over navigable waters, and are each furnished with a draw : —

I. — BRIDGES WHOLLY SUPPORTED BY BOSTON.

Ashland street, Ward 23, over Boston & Providence Railroad.

Athens street, over N.Y. & N.E. Railroad.

Berkeley street, over the Boston & Albany Railroad.

Berkeley street, over Boston & Providence Railroad.

*Broadway, over Fort Point Channel.

Brookline avenue, over Muddy river, Ward 22.

*Charles river, from Boston to Charlestown.

*Chelsea (South), over South Channel Mystic river.

*Chelsea street, from East Boston to Chelsea.

Columbus avenue, over Boston & Albany Railroad.

- *Commercial Point, or Tenean, Ward 24.
- *Congress street, over Fort Point Channel.
Dartmouth street, over Boston & Albany and Boston & Providence Railroad.
- *Dover street, over Fort Point Channel.
- *Federal street, “ “ “ “
Ferdinand street, over Boston & Albany Railroad.
Huntington avenue, over “ “ “ “
- *Malden, from Charlestown to Everett.
- *Meridian street, from East Boston to Chelsea.
Mill-dam, over Back-Bay sluices.
- *Mt. Washington avenue, over Fort Point Channel.
Newton street, over Boston & Providence Railroad.
Public Garden, foot-bridge.
Shawmut avenue, over Boston & Albany Railroad.
Swett street, east of N.Y. & N.E. Railroad.
Swett street, west of N.Y. & N.E. Railroad.
- *Warren, from Boston to Charlestown.
West Chester park, over Boston & Albany Railroad.
West Chester park, over Boston & Providence Railroad.
Winthrop, from Breed's Island to Winthrop.

II. — BRIDGES OF WHICH BOSTON SUPPORTS THE PART WITHIN ITS LIMITS.

- *Cambridge street, from Brighton (Ward 25) to Cambridge.
Central avenue, from Ward 24 to Milton.
- *Chelsea (North), from Charlestown to Chelsea.
- *Essex street, from Ward 25 (Brookline) to Cambridge.
- *Granite, from Dorchester (Ward 24) to Milton.
Longwood avenue, from Ward 22 to Brookline.
Mattapan, from Ward 24 to Milton.
Milton, “ “ “ “ “
- *Neponset, “ “ “ “ Quincy.
- *North Beacon street, from Ward 25 to Watertown.
- *North Harvard street, from Ward 25 to Cambridge.
Spring street, from West Roxbury (Ward 23) to Dedham.
- *Western avenue, from Ward 25 to Cambridge.
- *Western avenue, from Ward 25 to Watertown.

III — BRIDGES OF WHICH BOSTON PAYS A PART OF THE COST OF MAINTENANCE.

- Albany street, over Boston & Albany Railroad.
- *Canal, from Boston to Cambridge.
Dorchester street, over Old Colony Railroad.
- *Prison Point, from Charlestown to Cambridge.
- *West Boston, from Boston to Cambridge.

IV. — BRIDGES SUPPORTED BY RAILROAD CORPORATIONS.

1st. — Boston & Albany Railroad.

Brighton Avenue, Ward 25.

Harrison avenue.

Market street, Ward 25.

Tremont street.

Washington street.

2d. — Boston & Maine Railroad.

Mystic avenue.

Main street.

3d. — Boston & Providence Railroad.

Beach street, Ward 23.

Bellevue street, Ward 23.

Centre street, or Hog Bridge, Ward 23,

Centre and Mt. Vernon streets, Ward 23.

Dudley avenue, Ward 23.

Park street, Ward 23.

Sharon street, Ward 23.

4th. — Boston, Revere Beach, & Lynn Railroad.

Everett street.

5th. — Eastern Railroad.

Mystic avenue.

Main street.

6th. — New York & New England Railroad.

Broadway.

Dorchester avenue.

Fifth street.

Forest Hill avenue, Ward 24.

Fourth street.

Harvard street, Ward 24.

Norfolk “ “ “

Norfolk “ “ “

Second street.

Silver street.

Sixth street.

Third street.

Washington street, Ward 24.

7th. — Old Colony Railroad.

Adams street.

Ashmont street and Dorchester avenue.

Cedar Grove cemetery.

Commercial street.

Savin Hill avenue.

RECAPITULATION.

I. Number wholly supported by Boston . . .	30
II. Number of which Boston supports the part within its limits	14
III. Number of which Boston pays a part of the cost of maintenance	5
IV. Number supported by Railroad Corporations:—	
1. Boston & Albany	5
2. Boston & Maine	2
3. Boston & Providence	7
4. Boston, Revere Beach, & Lynn	1
5. Eastern	2
6. New York & New England	13
7. Old Colony	5
Total number	84

1. — BRIDGES WHOLLY SUPPORTED BY BOSTON.

ASHLAND-STREET BRIDGE (OVER BOSTON & PROVIDENCE
RAILROAD, WARD 23).

This bridge is in good condition. The abutments need repointing, and the girders should be painted during the coming year.

No repairs have been made the past year.

ATHENS-STREET BRIDGE (OVER NEW YORK & NEW ENG-
LAND RAILROAD).

No repairs have been made, but the bridge is in good order. It will probably require painting this season.

BERKELEY-STREET BRIDGE (OVER BOSTON & ALBANY
RAILROAD).

This bridge is not equal in strength to the bridges of more recent construction. It was built by the Moseley Iron Bridge Works for the Boston Water Power Co., and came into the possession of the city when the street was accepted.

Since then it has been strengthened and is now in good condition, but its position on a wide thoroughfare brings it in the route of many large processions, and while no special signs of weakness have been discovered, it requires careful watching, and should be replaced before many years by a stronger structure.

The abutments are built of Roxbury stone, laid dry, and are very poorly constructed.

The roadway has been sheathed.

Total cost of repairs, \$116.18.

BERKELEY-STREET BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).

The roadway of this bridge has been sheathed during the year.

On Dec. 5 a derailed engine struck three of the cast-iron supporting columns, knocking them out of position, but fortunately doing no other damage to the bridge. The repairs were made by the railroad company.

The iron-work will probably require repainting in the spring; otherwise the bridge is in good condition.

Total cost of repairs, \$536.66.

* BROADWAY BRIDGE (OVER FORT POINT CHANNEL).

The main item of repairs during the year has been a new under floor for the draw. This consists of 3½-inch white pine, calked and paid; the draw is now in excellent condition.

The sheathing of all the truss spans has been renewed during the year.

The wood pavement between the draw and the Lehigh-street span is in bad order, and must be renewed in the spring. The draw-pier, as mentioned in previous reports, is in a somewhat insecure condition, due to the gradual destruction by worms of the spruce sheet-piling which supports the structure. No especial change for the worse has, however, been noticed during the year.

The iron-work will require cleaning and painting in the spring.

Total cost of repairs, \$3,621.45.

BROOKLINE-AVENUE BRIDGE (OVER MUDDY RIVER)

Is in fair condition.

* CHARLES-RIVER BRIDGE (FROM BOSTON TO CHARLES-TOWN).

The usual repairs have been made, and the bridge is in good condition.

A small addition to the horse-house has been built for the better accommodation of the horses. The bridge and buildings have been painted, and a new buoy has been placed below the bridge.

Total cost of repairs, \$2,347.40.

* CHELSEA-STREET BRIDGE (FROM EAST BOSTON TO CHELSEA).

The draw to this bridge is in poor condition. It is not used for the passage of vessels to any extent; otherwise it would require rebuilding. The fixed part of the bridge is in good condition.

Total cost of repairs, \$186.93.

COLUMBUS-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).

None but ordinary repairs have been made. The bridge is in good order.

Total cost of repairs, \$198.93.

* COMMERCIAL POINT, OR TENEAN BRIDGE (WARD 24),
Has received the usual repairs, and the bridge is in fair condition.

Total cost of repairs, \$388.06.

* CONGRESS-STREET BRIDGE (OVER FORT POINT CHANNEL).

The opening of A street for public travel, and the occupation of the South Boston Flats by the New York & New England Railroad Company, have caused a large increase in the traffic over this bridge.

In October the draw was run into by a coal steamer, which cut through the sidewalk, and nearly through the lower chord of one of the main trusses. It was thoroughly repaired, and has apparently sustained no permanent injury.

The centre pivot bearing of the draw was examined in October, and found so badly worn that steps have been taken to provide a new one.

The bridge, as a whole, is in good condition.

Total cost of repairs, \$2,569.59.

DARTMOUTH-STREET BRIDGE (OVER BOSTON & ALBANY AND
BOSTON & PROVIDENCE RAILROADS).

The roadway has been sheathed, and all the iron-work underneath the floor has been painted. It is now in good order.

Total cost of repairs, \$593.49.

* DOVER-STREET BRIDGE (OVER FORT POINT CHANNEL)

Has required only ordinary repairs, and is in good order.

Total cost of repairs, \$858.14.

* FEDERAL-STREET BRIDGE (OVER FORT POINT CHANNEL).

The trusses of the southerly draw have been repaired, and the floors of the sidewalks have been renewed and strengthened. The draw-piers need replanking, and the roadway floor will soon require renewal.

Total cost of repairs, \$3,028.32.

FERDINAND-STREET BRIDGE (OVER BOSTON & ALBANY
RAILROAD).

But few repairs have been made, and it is in fair condition. The bulkhead adjoining the bridge remains in the unsafe condition reported last year.

Total cost of repairs, \$63.46.

HUNTINGTON-AVENUE BRIDGE (OVER BOSTON & ALBANY
RAILROAD).

The iron-work has been thoroughly cleaned and painted, and the bridge is in good condition.

Total cost of repairs, \$400.57.

* MALDEN BRIDGE (FROM CHARLESTOWN TO EVERETT).

Very few repairs have been required, but the bridge is in good condition. It should be painted the coming season.

Total cost of repairs, \$184.20.

* MERIDIAN-STREET BRIDGE (FROM EAST BOSTON TO
CHELSEA).

The bulkheads and fences on the main bridge are decayed and need renewal; otherwise the bridge is in fair condition.

The stone bulkheads across the bridge, at the ends of the draw, which have proved a constant source of annoyance and expense, have been removed, and wooden bulkheads substituted.

Total cost of repairs, \$1,939.63.

MILL-DAM BRIDGE (OVER BACK-BAY SLUICES).

The Roxbury stone piers of this bridge are not in good condition, but will probably continue to do their work until the completion of the new Beacon-street bridge and the filling of the Back Bay render the sluices unnecessary.

No repairs have been made.

*MT. WASHINGTON-AVENUE BRIDGE (OVER FORT POINT CHANNEL).

This bridge has been painted, its fender guards rebuilt, the roadway floor patched, and other smaller repairs made. The floor of the roadway is in bad condition, and should be entirely renewed. The floor of the draw is also weak, and will require strengthening the coming year.

Total cost of repairs, \$4,687.25.

NEWTON-STREET BRIDGE (OVER BOSTON AND PROVIDENCE RAILROAD).

I renew the recommendation of last year that the abutments be extended and pointed.

The bridge is otherwise in good condition.

No repairs have been made.

PUBLIC GARDEN FOOT-BRIDGE.

The stone work of this bridge should be pointed, and the wood and iron work painted.

SHAWMUT-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).

This bridge is in fair condition; but it should be painted this year.

Total cost of repairs, \$6.19.

SWETT-STREET BRIDGES (OVER SOUTH-BAY SLUICES)

Are in fair condition.

*WARREN BRIDGE (FROM BOSTON TO CHARLESTOWN).

The roadway near the Fitchburg Railroad station has been strengthened by additional stringers put in place from below; the sidewalks on the draw have been relaid, and the usual repairs made.

The bridge, as a whole, is in bad condition; the larger part of the supporting piles were driven when the bridge was built, in 1828; they were not so large as piles used in later

years, and have been reduced in size by the action of water and ice. The portion of the bridge near the Fitchburg Railroad station was built in 1847, to facilitate the placing of the station in its present position, and the piling and superstructure of this part of the bridge have not been renewed since that time. The superstructure of the remaining portion was renewed in 1855.

As this bridge shows no exception to the general rule, that the older any portion of a bridge is the poorer its condition, it follows that the piles are in the worst condition on that part of the bridge between the draw and Charlestown, and the flooring and timbers are the poorest portions of the section between the draw and Boston.

The subject of increased bridge accommodations between the city proper and Charlestown has been carefully considered by a special committee of the City Council during the past year, and a report has been made (City Doc. No. 143, 1880) which gives the results of their investigations.

It will be evident, from the preceding statements of the age and present condition of this bridge, that it is not a proper structure, as a whole, to be the main avenue of communication between the city proper and Charlestown. It will last, with careful watching and repairing, for several years more; but its width at the present time is inadequate for the travel over it, and it would probably be better economy to rebuild and widen it than to let it stand much longer in the condition it is now.

The total cost of repairs was \$1,586.89.

WEST CHESTER PARK BRIDGE (OVER BOSTON & ALBANY RAILROAD).

This bridge is in good order. .

No repairs have been made.

WEST CHESTER PARK BRIDGE (OVER BOSTON & PROVIDENCE RAILROAD).

The roadways have been replanked.

The bridge is in fair condition; both this and the preceding bridge should be painted next season.

Total cost of repairs, \$45.70.

WINTHROP BRIDGE (FROM BREED'S ISLAND TO WINTHROP)

Is in good condition.

No repairs have been made.

II. — BRIDGES OF WHICH BOSTON SUPPORTS THE PART WITHIN ITS LIMITS.

* CAMBRIDGE-STREET BRIDGE (FROM WARD 25 TO CAMBRIDGE).

Only ordinary repairs have been made; the bridge needs replanking, and the work will be done this winter, if the weather permits.

Total cost of repairs, \$163.58.

CENTRAL-AVENUE BRIDGE (OVER NEPONSET RIVER, DOR- CHESTER LOWER MILLS).

This bridge is in excellent condition.

No repairs have been made.

* CHELSEA BRIDGE, SOUTH (FROM CHARLESTOWN TO THE BOSTON & LOWELL RAILROAD WHARF),

and

* CHELSEA BRIDGE, NORTH (FROM THE MYSTIC RIVER CORPORATION'S WHARF TO CHELSEA).

The reconstruction of the old Chelsea bridge, partially made in 1866-7, has been completed during the past year, and the last portion of the old bridge of the Salem turnpike and Chelsea Bridge Corporation, built in 1802-3, has been removed. When the work of reconstruction was commenced, in 1876, the bridge was 3,300 feet long between abutments; since then 182 feet in length at the Charlestown end, 250 feet at the Chelsea end, and 1,263 feet in the central part of the bridge, have been filled solid, making two bridges in lieu of one. These bridges are separated by nearly a quarter of a mile of solid street, and each is provided with a draw for the passage of vessels. The bridge over the south channel, on the Charlestown shore, which was built in 1877, and is 371 feet in length, is in good condition; only ordinary repairs have been made upon it. A full description of this structure may be found in the Report of 1878 (City Doc. 20).

The bridge over the main channel of the Mystic river, or "Chelsea bridge, North," with the exception of the draw and its foundations, has been rebuilt during the year, from 19 feet north of the draw to the Boston abutment, by Boston, and the remainder by Chelsea. The portion now maintained by Boston is 922 feet in length, including the draw.

An Act of the Legislature of 1878 (Chapter 41) provided that Boston should maintain all that portion of the bridge lying southerly of the draw, and that the draw should be maintained jointly by Boston and Chelsea. The agreement made last year with Chelsea, by which that city was to pay \$25,000, and Boston was to assume the future maintenance of the draw, draw-piers, and the portion of the bridge between the draw-piers when rebuilt, has been consummated, the assent of the Legislature having been previously obtained. The care of the draw was assumed by Boston, June 1, 1880.

The work of rebuilding the portion of the bridge belonging to Boston was done, under contract, by Messrs. Young & Ryan, the contract price being \$44,937.

The bridge was closed to travel on June 8. The rebuilding was sufficiently advanced by September 22 to admit of the resumption of travel, but owing to the non-completion of the portion rebuilt by Chelsea the travel was not resumed until December 1. The new bridge is 49 feet in width, with one sidewalk 8 feet wide. It is built in a substantial manner, with oak piles and hard-pine caps, bolsters, stringers, and floor. The road-way floor is 6 inches thick, laid with close joints, calked and covered with a layer of Trinidad asphalt, and paved with granite blocks. The sidewalk is coal-tar concrete on a floor of creosoted North Carolina pine. The fences are white pine, neatly painted.

The draw-piers are 19 feet in width, and are respectively 170 and 180 feet in length. They have oak pile foundations, with hard-pine timber superstructures, and creosoted North Carolina pine floors. The bents of piles are cross-braced with oak, and the ends of the piers protected with iron straps. The sides of the water-ways are planked to a line one foot above low-water mark. The pier on the westerly side of the bridge occupies the place of the old one; on the easterly side the pier is built on the side of the channel opposite to the old pier. Both piers are now on the Chelsea side of the channel.

Two buoys have been placed, one above and one below the bridge, to facilitate the passage of vessels through the draw-way.

A work-shop has been built on the draw-pier, and a building containing the Superintendent's office, two sleeping-rooms, and a convenient stable, has been built on a small wharf adjoining the bridge near the draw.

The draw has been repaired and painted, an entirely new floor laid, and a sidewalk built upon it.

The cost of the entire work of rebuilding, including

engineering, superintendence, building and furnishing Superintendent's office, etc., and all expenses incurred up to Jan. 1, 1881, was \$50,477.08.

Total cost of ordinary repairs on both bridges, \$1,693.66.

***ESSEX-STREET BRIDGE (FROM WARD 25 TO CAMBRIDGE).**

A short piece of this bridge from the railroad crossing to the abutment has been newly covered with a hard-pine floor, calked and paid, and the whole bridge surface has been replanked. The bridge is now in good condition.

Total cost of repairs, \$1,368.05.

***GRANITE BRIDGE (FROM WARD 24 TO MILTON).**

Only ordinary repairs have been made, and it is in fair condition.

Total cost of repairs, \$116.03.

LONGWOOD-AVENUE BRIDGE (FROM WARD 22 TO BROOK-LINE).

A new floor has been laid on the part supported by Boston. The bridge is in good condition.

Total cost of repairs, \$282.04.

MATTAPAN BRIDGE (FROM WARD 24 TO MILTON).

This bridge is a weak structure, but in fair condition. No repairs have been made.

MILTON BRIDGE (FROM WARD 24 TO MILTON).

This bridge is in fair condition.

No repairs have been made during the year.

***NEPONSET BRIDGE (FROM WARD 24 TO QUINCY).**

This bridge has been painted, and a few minor repairs have been made; it is in good condition.

Total cost of repairs, \$123.85.

***NORTH BEACON-STREET BRIDGE (FROM WARD 25 TO WATERTOWN).**

No repairs have been made on this bridge. The lower course of floor-plank is in bad condition, and will have to be renewed this year.

***NORTH HARVARD-STREET BRIDGE (FROM WARD 25 TO CAMBRIDGE).**

Only trifling repairs have been made; it is in excellent condition.

Total cost of repairs, \$30.80.

SPRING-STREET BRIDGE (FROM WARD 23 TO DEDHAM).

With the exception of the railing, which is poor, and to which attention has been called for several years, this bridge is in good order.

* WESTERN-AVENUE BRIDGE (FROM WARD 25 TO CAMBRIDGE).

This bridge, completed during the early part of the year, was described in the last annual report. Very few repairs have been needed, and it is now in excellent condition.

Total cost of ordinary repairs, \$404.31.

* WESTERN-AVENUE BRIDGE (FROM WARD 25 TO WATERTOWN).

Estimates and plans for rebuilding this bridge, and a model of a leaf draw applicable to the very sharp angle which the bridge makes with the river, were made early in the year; but the town of Watertown did not wish to coöperate with the city in rebuilding the bridge, so nothing further was done. The reconstruction of the bridge was recommended by the Committee on Bridges of last year, and is a very much needed improvement. Great inconvenience is experienced on account of the difficulty of passing vessels through the draw, and the long time consumed in doing it.

The bridge is in safe condition; but the abutment overhangs its base, and is liable to fall.

Total cost of repairs, \$266.88.

III.—BRIDGES FOR MAINTENANCE OF WHICH BOSTON PAYS A PART OF THE COST.

ALBANY-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).

The abutments are in very bad condition, and the bridge is rapidly deteriorating from the effects of rust.

The abutments ought to be rebuilt, and if the bridge was removed for this purpose it would not probably be worth putting back again.

Total cost of repairs, \$98.11.

* CANAL BRIDGE (FROM BOSTON TO CAMBRIDGE).

* PRISON-POINT BRIDGE (FROM CHARLESTOWN TO CAMBRIDGE).

* WEST BOSTON BRIDGE (FROM BOSTON TO CAMBRIDGE).

These three bridges are in good order.

[See Report of the Commissioner for Boston, City Doc. No. 8, 1881.]

DORCHESTER-STREET BRIDGE (OVER OLD COLONY RAILROAD).

Nothing has been done to arrest the rusting out of this bridge, and its condition cannot be better expressed than by the use of the language in the last report: "The bridge is badly damaged for want of proper care; just how badly cannot be known until it is stripped and cleaned. Enough is known of its condition to warrant the statement that unless it is cleaned and painted soon it will last but a few years more."

IV.—BRIDGES SUPPORTED BY RAILROAD CORPORATIONS.

The bridge on Commercial street, Dorchester, over the Old Colony Railroad, is in bad condition. The main trusses are old and rotten, and the floor timbers should be supported on a wall plate instead of the insecure blocking now in use.

The surface of the bridge on Centre and Mt. Vernon streets, over the Dedham branch of the Boston & Providence Railroad, is inclined in the wrong direction, and water stands upon it after a rain.

The bridge on Broadway, over the New York and New England Railroad, is in bad condition, the under floor being especially poor and rotten.

The remaining bridges in this class are apparently in good order, and require no special mention. Most of them are simple platforms of wood, and when under repair their condition can be ascertained with ease. To obtain the information which would enable this department to report with certainty as to their safety it would be necessary to remove the flooring, — usually in two thicknesses, crossing each other at right angles, — and as there seems to be no special necessity for incurring so large an expense, this has never been done. The most, therefore, that can be said of these bridges is that they are apparently, and probably, in safe condition, with the exceptions mentioned.

MISCELLANEOUS WORK AND CONSTRUCTIONS IN 1880.

ALFORD-STREET SEA-WALL.

Plans and specifications for increasing the height of the sea-wall on Alford street, Charlestown (near Malden Bridge), and for a fence and sidewalk on the same, have been made.

A contract, dated Nov. 8, 1880, was made with Charles T. Derry, for doing the work, for the sum of \$3,494, and it is now partially completed.

The top of this wall was considerably below the street filling, and the work now in progress to remedy this defect consists in rebuilding a small portion of the wall, and setting a course of cap-stones on it at the established grade for its entire length. A new fence and a creosoted plank sidewalk are also included in the contract. The wall is 1,100 feet in length. No payment on account of this work has yet been made.

BEACON-STREET BRIDGE.

Early in the year plans and specifications were prepared for the foundations of a new bridge, and a temporary dam in connection therewith, at the outlet of the Back-Bay park pond. The contract for this work was awarded to Ross & Lord, who commenced operations August 12, but have not yet completed it.

The bridge is to consist of two spans, of 20 feet each, over the sluice-way from the park pond. Five and one-half feet north of the northerly line of Beacon street there is to be a dam, with self-operating swinging-gates, across the sluice-way.

The top of this dam is to be at grade 6.5 above city base, with flash-boards of sufficient height to prevent the surface of the park pond from falling below grade 8, unless the flash-boards are removed. The gates are to be over the dam, forming a part of it, and are to open outwards.

When the surface of the pond rises above grade 8, the water will discharge over the dam, unless the tide outside should be higher than this grade; in which case the gates shut out the tide, and no water will then run over the dam until the tide level is lower than the pond.

This dam in its present form and location is a temporary structure, which is only intended to remain until it is determined what is to be done with the flats on the Charles-river side of Beacon street. When this question is settled, and the lines of improvement are defined, it will be necessary to build a permanent dam and gate-chamber in some other location on the extension of the sluice-way. Its construction at the present time is for the purpose, in connection with the covered channel of Stony Brook, of controlling the height of the water in the pond, so that the necessary work can be done within the Park limits.

Provision has been made in the contract for building across Beacon street a portion of the covered channel of

Stony Brook, so that it will not be necessary to again interrupt travel over it for this work.

The travel over Beacon street is now maintained by means of a road-way filled around the site of the bridge on the southerly side of the street; a water-pipe is laid temporarily in this road-way, to prevent any interruption of the flow through the 40-inch main.

The amount of the contract for the bridge foundations and dam is \$36,898, and there has been paid for work done, and materials furnished, the sum of \$12,490.15.

On Dec. 30, 1880, a contract was made with David H. Andrews, of the Boston Bridge Works, to build an iron deck bridge, and a wrought-iron water pipe to connect with the 40-inch main, for the sum of \$4,693. The bridge and pipe are to be completed and erected within thirty days from the date of the completion of the abutments and central pier.

BEACON-STREET WIDENING.

The contract with Martin Lennon, of Boston, for widening the section of Beacon street between West Chester Park and the intersection of the former street with Brighton and Brookline avenues, was finished Aug. 18, 1880. The character of the work is fully described in the last annual report.

The total amount expended for work under the contract was \$19,143.99.

BROADWAY EXTENSION (OVER THE BOSTON AND ALBANY RAILROAD).

Plans and specifications for abutments for a bridge over the Boston and Albany Railroad, and for retaining-walls from the abutments to the streets nearest to the bridge, have been prepared. A contract, dated Sept. 3, 1880, was made with John Cavanagh & Co. for building the same, for the sum of \$64,900. The sharp angle which the bridge makes with the railroad necessitates abutments, each 119 feet in length, on the foundation line. The width of the roadways on each side of the railroad, from the abutments to the streets, is 62 feet, the top of the retaining-walls being set one foot over the line of the abutting premises by agreement with the Boston & Albany Railroad Co.

The work is being actively prosecuted, and the foundations for the abutments and the larger part of the foundations for the retaining walls are completed. The abutments above the foundations have been commenced, and most of the cut

stone required for completing them has been delivered. It is expected that the work will be so far advanced early in the season as to be in readiness for the superstructure.

The total amount paid to the contractor, including the January estimate, was \$22,569.37.

The plans for the iron bridge superstructure are in progress. The span will be 144 feet.

COMMONWEALTH-AVENUE EXTENSION.

In February negotiations were begun between the city and owners of the land bounded by Beacon street, West Chester park, Brookline avenue, and the Boston & Albany Railroad, having for their object a mutual agreement for the filling of that territory. Surveys and soundings were made by this department in conjunction with Messrs. Fuller and Whitney, engineers for the land-owners, to complete and verify a survey commenced previously by Messrs. Fuller and Whitney. March 20, 1880, an agreement was entered into between the City of Boston, the Boston Water Power Co., the Trustees of the Beacon-street lands, and Alfred A. Marcus, for the filling jointly of this territory.

Proposals were advertised for, and April 29, 1880, separate contracts were made with the Boston & Albany Railroad Company, by the Committee on Streets and Park Commissioners for the City of Boston, and the Boston Water Power Co., and the Trustees of the Beacon-street lands, for filling the area between Beacon street, Brookline avenue, the Boston & Albany Railroad, and the easterly line of 50-foot street bordering on the easterly side of the Beacon entrance of the Back-Bay park.

Work was begun on this filling April 26, 1880, and the quantity of gravel deposited upon the territory, to and including December 31, 1880, was 94,106 car-loads, amounting to 37,350 squares. Of this amount the approximate estimates show that there have been deposited, —

Upon land of the B. & A. R.R. Co.	795 squares
“ “ “ “ Boston Water Power Co.	6,856 “
“ “ “ “ Trustees Beacon-st. lands	7,737 “
“ Back-Bay park	6,847 “
“ Commonwealth avenue and adjacent streets	15,115 “
Total	<u>37,350</u>

By the terms of the several contracts the entire work is to be completed August 1, 1881.

Until December 9 the gravel was brought from the bank at Weston which was used for the park filling under the contract of 1879. Since December 9 it has been brought from a bank recently opened by the company in Newton, near Riverside Station.

ROXBURY-CANAL IMPROVEMENT.

The work of filling that portion of Roxbury canal west of West Chester park was commenced October 11, 1878, and was finished March 26, 1880; during this time 6,352 squares of filling were deposited in the canal, at a cost, including dumping, measurement of carts and superintendence, of \$17,445.79.

The total amount expended for work done under the supervision of this department was \$31,261.35.

The Joint Special Committee on Improved Sewerage, in charge of this improvement, settled with Joseph Ham, December 31, 1880, for damages caused by taking his land. The amount paid was \$79,000. This was the only claim remaining unsettled except that of George Curtis.

SOUTH-BAY DAM.

This dam was built for the Board of Health. The Board was directed, by an order passed by the City Council, July 26, 1880, to abate a nuisance on that portion of the South-Bay flats between the New York & New England Railroad and Dorchester avenue north of Swett street, and the sum of \$4,600 was appropriated for the purpose.

A license was obtained from the Harbor and Land Commissioners for the construction of a temporary dam from "Wales Island" to the embankment of the N.Y. & N.E. R.R. Plans and specifications were made for it, and the contract for the wood-work was awarded to F. G. Whitcomb, Oct. 1, 1880; the ballasting was awarded to C. H. Edwards.

The dam is 522 feet in length, with sluices 24 feet in length, and consists of a line of sheet-piling driven between two rows of spruce piles. The piles are driven in pairs 15 feet apart, except at the sluices, where they are 6 feet apart measuring on the line of the dam. The sheet-piling is securely spiked near the top to a double line of spruce stringers, which are bolted to the piles with 1-inch diameter wrought-iron bolts.

The dam is ballasted on both sides.

The top of it is at grade 5, with the sluices at grade 0.

Its construction was commenced Oct. 4, and work upon it was stopped Nov. 26.

Owing to the neglect of the contractor for the ballast to furnish it as rapidly as it was required a portion of the sluice-way, 35 feet in length, was carried away. The gap has been filled up to low water with heavy riprap, and, as soon as the weather permits, the work of closing it will be finished.

The amount expended for the wood-work was \$2,680.42; for the ballast, to Jan. 1, was \$1,260.50.

Total amount expended to Jan. 1, 1881, including construction, measurement of scows, etc., \$4,048.92.

IN GENERAL.

A considerable amount of work of a miscellaneous character has been done during the year. Under this head may be classed plans and estimates for a bridge, abutments, and retaining-walls at Mt. Hope Station, on the Boston and Providence Railroad; plans for the improvement of Stony Brook in Brookside avenue, Ward 23; estimates for the extension of D street across the Old Colony Railroad; measurement of stone for temporary dam at the Mill Dam sluices; supervision of repairs on bridges in charge of Paving Department; estimates and plans, involving a large amount of office-work, for a new bridge to Charlestown, etc., etc.

In the draughting-room an unusually large amount of work of a miscellaneous character, consisting of copying, blue-printing, tracing, and revising plans, has been done, and estimates of cost have been made for bridges in the Back-Bay park, for a draw for the proposed Northern-avenue bridge, and designs for a new bridge to Charlestown. A large number of plans for work at the Improved Sewerage Pumping-Station; also plans and specifications for an iron bridge on Beacon street, and for an office and stable on Chelsea bridge, have been made.

Detail plans for the iron bridge for the Broadway extension are now in progress.

B. — WATER WORKS.

Sudbury River Reservoirs. — During the first five months of the year 1880 the water in all the reservoirs remained at or near the crests of the dams, and for the greater portion of the time the water was wasting at the overflow of dam No. 1. After August 1 the water-level of reservoir No. 1 slowly fell, until on the first of January, 1881, it stood 2.48 feet below the top of the flash-boards.

During the summer, owing to the presence of algæ in reservoirs Nos. 1 and 3, the supply for the city was drawn mainly from reservoir No. 2, until August 18, when the surface of that reservoir was 8.93 feet below the crest of the dam. From that time until the 2d of November the supply was drawn from reservoir No. 3, and on October 30 the water-level of this reservoir was 15.65 feet below the crest of the dam. Reservoir No. 2 meanwhile had filled to within $2\frac{1}{2}$ feet of the top of the dam, and during the last two months of the year the supply was drawn from that reservoir. On the first of January, 1881, the surface of reservoir No. 2 was 5.70 feet below the crest of the dam, and reservoir No. 3 was 11.47 feet below the corresponding point.

During the year 6,230,200,000 gallons have been drawn from the Sudbury-river works for the supply of the city as follows: —

	Amount sent to Chestnut Hill Reservoir.	Amount sent to Lake Cochituate.	Total.
January . . .	673,600,000	228,400,000	902,000,000
February . . .	604,100,000	11,300,000	615,400,000
March . . .	268,400,000	8,200,000	276,600,000
April . . .	348,000,000	161,300,000	509,300,000
May . . .	460,000,000	280,800,000	740,800,000
June . . .	398,600,000	136,700,000	535,300,000
July . . .	378,400,000		378,400,000
August . . .	592,000,000		592,000,000
September . . .	445,500,000		445,500,000
October . . .	434,600,000		434,600,000
November . . .	398,200,000		398,200,000
December . . .	402,100,000		402,100,000
Totals . . .	5,403,500,000	826,700,000	6,230,200,000
Daily averages	14,763,660	2,258,740	17,022,400

The daily average amount supplied to the city from the Sudbury river during the year was 17,022,400, or 64 per cent. of the total consumption.

The average daily yield of the river for the past six years has been as follows: —

		Total yield.	Daily average.	Rainfall.	Percentage.
1875	.	27,593,700,000	75,599,200	45.49	44.88
1876	.	32,309,900,000	88,278,400	49.563	48.24
1877	.	34,444,750,000	94,369,200	44.018	57.90
1878	.	41,202,000,000	112,882,200	57.931	52.63
1879	.	25,528,900,000	69,942,200	41.419	45.33
1880	.	16,561,600,000	45,250,300	38,177	32.71

Lake Cochituate. — On the first of January, 1880, the surface of Lake Cochituate was 7.86 ft. below high-water mark; from Jan. 1 to May 1, the water was rising, standing Feb. 1, 129.28; March 1, 132.00; April 1, 132.88, and May 1, 134.10 above tide marsh level. During the month of May it remained near this grade, and after July 1 it steadily fell, until, on Jan. 1, 1881, it was 125.62 above tide-marsh level, or 8.74 feet below high-water mark.

Mystic Lake. — At the beginning of the year 1880, the water in Mystic Lake was 1.71 ft. above tide-marsh level, or 5.88 ft. above the conduit invert. Jan. 25 it had risen to 6.65 ft., and was allowed to waste at the outlet dam. The waste continued until April 28, and from May 1 to 12, since which time no water has passed over the dam. From the middle of May the surface of the lake fell, standing July 1, 3.26; Aug. 27, 1.50, or at the top of the conduit; September 1, 1.34, and on October 1, 0.92. On the 3d of September the Water Board authorized the erection of pumping machinery at the lake, to raise the water into the conduit.

The engines and pumps which were used at Lake Cochituate in 1871 and 1874, for a similar purpose, were transported to Mystic Lake, and placed in position upon temporary platforms which had been built to receive them. October 2, as the conduit by gravitation would no longer furnish the supply, the pumps were started and were continued in operation until the 17th of January, 1881.

On the 25th of October the lake surface was 3.18 feet below tide-marsh level, or only one foot above the conduit invert; the lowest point ever reached. Jan. 1st it was 1.66 feet below tide-marsh level. At the present time (Feb. 1) it is 0.41 ft. above tide-marsh level, or 6.59 ft. below high-water mark.

Consumption. — The average daily consumption for each month of the year has been as follows: —

	From the Sudbury and Cochituate Works.	From the Mystic Works.	Total.
January . . .	25,817,600	10,511,280	36,328,880
February . . .	27,625,800	11,616,250	39,242,050
March . . .	23,095,700	10,324,320	33,420,020
April . . .	22,670,700	9,400,930	32,071,630
May . . .	25,238,200	9,962,210	35,200,410
June . . .	27,795,400	10,891,060	38,686,460
July . . .	26,951,800	10,051,540	37,003,340
August . . .	28,175,100	9,754,150	37,929,250
September . . .	28,734,400	9,591,890	38,326,290
October . . .	27,487,900	7,634,890	35,082,790
November . . .	26,458,400	6,245,890	32,704,290
December . . .	28,010,500	6,778,050	34,788,550
Averages . . .	26,500,000	9,387,880	35,887,880

From the above it appears that the daily average consumption from the Sudbury and Cochituate works has been 26,500,000 gallons, an increase of 3.1 per cent. over that of 1879; from the Mystic works 9,387,880 gallons, an increase of 5.7 per cent., and from the combined supplies 35,887,880 gallons, an increase of 3.8 per cent.

The total population of the territory supplied, which includes, in addition to the city of Boston, the cities of Chelsea and Somerville and the town of Everett, is about 412,000. The daily average consumption per head has, therefore, been about 87 gallons.

Since October 12 East Boston has been supplied from the Sudbury and Cochituate works.

HIGHLAND HIGH-SERVICE WORKS.

The average daily quantities of water pumped by the high-service engines at the Highland station, for each month, have been as follows:—

January,	2,249,000	July,	2,444,500
February,	2,340,500	August,	2,432,500
March,	2,166,500	September,	2,481,033
April,	2,174,133	October,	2,342,500
May,	2,468,000	November,	1,998,983
June,	2,799,300	December,	2,199,000

Making a daily average of 2,341,093 gallons for the year,—an increase of 4.1 per cent over the quantity pumped in 1879.

EAST BOSTON HIGH-SERVICE WORKS.

On May 15, 1880, the Water Board was authorized to construct high-service works for the supply of a portion of East Boston. Contracts were immediately made for the pipes, and pumping-machinery required. Plans having been made for the pumping-station the work was contracted for, and, on the arrival of the pipes, the whole work was rapidly pushed. On the 12th of October it was so near completion that the works were put in operation, the supply being changed from Mystic to Sudbury and Cochituate.

The works comprise 2 Worthington compound high-pressure pumps, together capable of raising 1,500,000 gallons in 24 hours; 2 upright tubular boilers for supplying steam for the pumps, a check-valve with a by-pass and safety-valve for regulating the pressure upon the pipes, and about 7,500 feet of main pipe connecting with the former supply mains.

The pumping-machinery is located in a neat wooden building, on Brooks street, in the reservoir lot, the supply for the pumps being taken from the 20-inch low-service main which supplies the district.

The territory supplied is comprised in two districts, the "Eagle Hill" and "Belmont Square," containing together about 850 buildings. The pumping-machinery was furnished by H. R. Worthington, of New York, for \$8,400; the engine-house foundations and chimney were built by Fessenden & Libby, of Charlestown, for \$1,989.66; and the engine-house, by Herman Drake, of East Boston, at a cost of \$2,205. The entire work has been completed at a cost of \$23,000.

FORTY-EIGHT-INCH MAIN.

During the last session of the Legislature an act was passed, granting to the City of Boston the right to lay a new main from the Chestnut-Hill reservoir to the city, through the town of Brookline, and on March 20 an order was approved by the Mayor, authorizing the Water Board to expend \$280,000 for the pipes and special castings required. In April contracts were made with the Warren Foundry & Machine Co., of Phillipsburg, N.J., and R. D. Wood & Co., of Philadelphia, for the pipes and special castings. In consequence of a fall in the price of iron the pipes were purchased for \$40.95 per ton, or about \$70,000 less than the amount appropriated. This amount has since been applied to defray the cost of laying the main, and the entire work will be completed within the first appropriation.

The work of laying the pipes was commenced on June 23, and at 12 M. of Nov. 29 water was supplied to the

city through the new main, direct from Chestnut-Hill reservoir. The pressure throughout the city was immediately increased about 10 feet.

A 30-inch main, to be charged to this appropriation, still remains to be laid in Francis street, to connect the 40-inch with the 30-inch and 36-inch mains, originally laid to supply the city, and it is expected that this connection will still further increase the head.

The new main starts from the effluent gate-house, at Chestnut-Hill reservoir, and after connecting with a 48-inch pipe, which is laid around the reservoir from the terminal chamber of the Sudbury-river conduit, it passes through Beacon street to the junction of Brookline avenue, — a distance of 16,300 feet, — where it connects with the 40-inch main from Brookline reservoir. At the junction of Harvard street, in Brookline, a branch has been put in for a contemplated connection with the Mystic works, and a gate is located in the main at this point. Gates to control the flow of the water have also been placed on the connection, at Chestnut-Hill reservoir and at Brookline avenue. Near St. Paul street, in Brookline, a section of the pipe line, 780 feet in length, is supported by a pile foundation, consisting of spruce piles driven in pairs, at distances apart of 5 feet crosswise, and 6 feet lengthwise of the trench, and capped crosswise with 10-inch by 10-inch spruce caps, 8 feet long.

The cost of the main was largely increased by the necessity of removing and relaying many of the water and gas pipes in the town of Brookline.

All of the work has been done by day's labor, under the direction of E. R. Jones, Superintendent of the Eastern Division of the Sudbury and Cochituate Department.

MISCELLANEOUS.

Exclusive of the new 48-inch main, about 9 miles of main pipe have been laid during the year, and 59 hydrants established by the Sudbury and Cochituate Department, and about 2 miles of the wrought-iron and cement pipe in the Charlestown District have been replaced by coated cast-iron pipe.

The plans of the pipe system have been corrected as usual, and a skeleton plan of the high-service system has been completed.

C. — ADDITIONAL SUPPLY.

SUDBURY-RIVER WORKS.

At the beginning of 1880 the whole system of the Sudbury-river Works, although not entirely completed in all its details, was in practical working order. The last contracts,

four in number, were finally completed in the early part of the year : three of them were for the gate-houses connected with each of the dams ; the other for the erection of a foot-bridge with flash-boards on the crest of dam No. 2. A considerable amount of minor work was also done by day's labor, under the direction of this department, to complete the dams and reservoirs, and to improve their borders. At dam No. 2 the impervious hearting of the embankment was extended several hundred feet on the high grounds, near the farm buildings of Jos. A. Merriam, by means of sheet piling and by puddling. The local engineering force, reduced to three assistants after the month of March, and subsequently to one, was entirely dispensed with in October. It had charge of the work of construction, of the maintenance of the portion of the works above the main gate-house in Farm Pond, and also completed the final records of the entire work.

On the 24th of September the following letter, which explains itself, was sent to the Water Board :—

LEONARD R. CUTTER, ESQ., *Chairman of Boston Water Board* :—

Dear Sir,—The work of building the Sudbury-river conduit, and the three basins authorized by the City Council, is, so far as this department is concerned, completed, and any further expenses on this work, except settlement of outstanding claims, should be, in my opinion, charged to *maintenance*, and not to *construction*.

Respectfully,

HENRY M. WIGHTMAN,

City Engineer.

And on October 15th, in accordance with a vote of the Water Board, the portion of the work left in charge of this department was transferred to the Superintendent of the Western Division of the Sudbury and Cochituate Works.

As this transfer closes the construction period of the Sudbury-river works, as they were contemplated in the original estimates, it may not be out of place to recall the principal data of this important scheme.

In 1871 and 1872 Sudbury river was selected as the new source of water-supply for Boston. The reservoirs for the storage of its waters, and the conduit through which they were to be conveyed from Farm pond to Chestnut-Hill reservoir, were located, and plans were made for the building of these structures.

In 1872, also, temporary works were built to connect at once Sudbury river with Lake Cochituate.

In 1873 the first contract was let for a portion of the conduit (the tunnel in Newton) ; but, owing to new investigations ordered by the City Council in the latter part of 1873 and in 1874, to ascertain whether Sudbury river was the

best source of supply, no other work was undertaken until the beginning of 1875.

The main portion of the conduit, commenced in 1875, was finished in 1877, and put in practical use early in 1878.

The three dams and reservoirs were commenced in 1876. Reservoir No. 3 was filled for the first time in December, 1878; Reservoir No. 1, and also No. 2, in 1879.

During the progress of construction the original design was followed with but few changes; some important additions were made, but the cost of the whole work has been kept inside of the first estimates.

On October 1, 1880, the total cost of the works of "additional supply" was \$5,234,678.02.

The water damages, not included in the original estimates, amounted to \$543,190.64.

Although the *final* completion of the "additional supply" is so recent, it will be remembered that, as early as 1872, the water from Sudbury river was used for replenishing Lake Cochituate, and that, from the beginning of 1875, a large proportion of the general supply has been taken from the new source. This proportion has increased every year at such a rate that the present supply taken from the river has reached the limit of capacity for which the present reservoirs were intended.

When Sudbury river was reported upon for the first time (City Document No. 29, 1873) it was shown that no less than eight storage basins would be necessary to develop its full resources. The conduits, and all their appertaining structures, are built in proportion with the ultimate capacity of the supply; but it was not advisable to build at once all the contemplated reservoirs. The consumption of the city being then about 19,000,000 gallons per day, it was decided to build three storage reservoirs only, and to postpone the construction of others until the increasing wants of the city should require them.

Now, with an average daily consumption for 1880 of 26,500,000 gallons, which during the severe weather of this winter has occasionally reached a maximum of more than 40,000,000 gallons per day, the time has already come to provide additional storage. This necessity has been forcibly illustrated by the condition of the supply for the last year, during which the rainfall has been exceptionally small, and the drought unusually severe.

Thus it happens that almost at the same time that the original works are reported as finally completed, a new appropriation of \$55,000 has been made for the purchase of land and for the investigations necessary for an additional storage reservoir.

Owing to the severity of the season surveys cannot be prosecuted to any advantage at present; but borings are being made to ascertain as soon as possible the best location for a new dam, and the nature of the ground in which its foundations are to be established. When the necessary information is obtained the work of construction should be commenced and prosecuted without delay.

The extension of the storage system is not likely to be limited to this structure for any length of time. Unless some method is adopted for reducing the waste of water, still larger storage facilities must be provided in the near future to accommodate, in a dry year, the constantly increasing consumption.

D. — IMPROVED SEWERAGE.

A general description of this system, accompanied by a map and plates, showing sections of the sewers, and elevation and plan of the Leavitt pumping-engines, was given in the last annual report.

The Leavitt engines, which are being built under a contract by the Quintard Iron Works, of New York, are in a forward state of completion; but will not be finished in the contract time. Payments on account of these engines to the amount of \$160,569.62 have been made, and material of the value of \$65,005.45 has been delivered at Old Harbor Point, where the contractor has erected a storehouse and machine-shop for temporary use.

Negotiations with Mr. Corliss for the building of two pumping-engines, from his own designs, after having been carried on by the committee at intervals during the year without attaining a satisfactory result, were finally closed on December 23, 1880. A contract was made with the successors of Mr. Henry R. Worthington, of New York, on December 30, 1880, for two pumping-engines of the Worthington Duplex type, to take the place of the Corliss engines. Each of the engines is to be of sufficient capacity to raise 25,000,000 U. S. gallons of sewage in twenty-four hours to a maximum height of 43 feet. The contract price for the two engines is \$90,000; but no payment is to be made until they are in running order at the pumping-station, and have passed a satisfactory test by the city.

A contract was made October 11, 1880, with Messrs. Kendall & Roberts, of Cambridgeport, for building, and erecting at the pumping-station, two steel boilers to furnish steam for the Leavitt engines.

These boilers are of the horizontal fire-box tubular form, 31 feet, $9\frac{3}{4}$ inches long over all, and of a mean diameter of 6 feet 8

inches in the cylindrical portions. Each boiler has two fire-boxes, 3 feet 6 inches wide at the bottom, 5 feet 2 inches high, and 11 feet long, connecting with a combustion chamber 4 feet long. The steel in the outer shell is $\frac{7}{16}$ inch, and in the fire-boxes and combustion chamber, $\frac{5}{16}$ inch thick. Each boiler contains 132 lap-welded wrought-iron tubes, 3-inch external diameter and 15 feet 1 inch long. The internal bracing of the boilers consists of knee-braces, screw-stays, and rods, all of Ulster iron. The boilers are connected to a steam drum, 2 feet in diameter by 14 feet 6 inches long, made of steel $\frac{5}{16}$ inch thick.

The fire-box ends of the boilers rest upon cast-iron ash-pits, and the cylindrical portions are supported by cast-iron cradles, three to each boiler. The boilers are provided with the necessary hand and man holes, safety-valves, blow-off pipes, etc.

The feed-pumps for the boilers are two in number, of the Worthington Duplex pattern, 6 inches \times 3 $\frac{1}{2}$ inches \times 6 inches, their suction-pipes being connected with a small water-heater, into which their exhaust steam, and that of the cold-water pumps for the Leavitt engines, is led.

The feed water is to be led through brass pipes, either direct to each boiler, or through a heater composed of 80 seamless brass tubes, 2 $\frac{1}{2}$ inches inside diameter, and 14 feet 10 inches long between connecting beams, which is placed inside of the smoke-flue leading from the boilers to the chimney.

After erection the boilers are to be covered with a lagging of non-conducting material.

Samples of the steel and iron used in the boilers were tested at the U. S. Arsenal at Watertown, Mass., and satisfactory results obtained.

The boilers are completed, but not yet delivered at the pumping-station. The contract price, including feed-pumps, heater, and all other appurtenances, was \$19,950.

The sum expended to January 1, 1881, chargeable to the appropriation for "Improved Sewerage," is \$866,374.47.

Extracts from the report of Mr. E. C. Clarke, principal assistant engineer on the improved sewerage system, showing the progress of the work, and other information in relation to it, are appended.

EXTRACTS FROM MR. CLARKE'S REPORT.

Herewith is submitted a report of work done and progress made in constructing the new system of sewerage, from Jan. 1, 1880, to Jan. 1, 1881. The following tabular statement shows the sizes and lengths of main, intercepting and outfall sewers built, with the portions of them completed during the past year, and is followed by a more detailed account of the work upon each section:—

TABULAR STATEMENT OF PROGRESS—

Section.	Locality.
1. Main	In Camden st., from Huntington ave. to Tremont st.
2. Main	In Camden st., from Tremont st. to Washington st.
3. Main	In Washington st. and E. Chester park, from Camden st. to Albany st.
4. Main	In E. Chester park extension, from Albany st. to Magazine st.
4½. Main	In E. Chester park extension, from Magazine st. to Clapp st.
5. Main	In Clapp and Mt. Vernon sts., from E. Chester park extension to O. C. Railroad
6. Main	In Mt. Vernon-st. extension, from O. C. Railroad to Old Harbor Point
1. West Side	In Camden, Falmouth, Dalton, and Hereford sts., from Huntington ave. to Beacon st.
2. West Side	In Beacon st., from Hereford st. to Charles st.
3. West Side	In Charles st., from Beacon st. to Cambridge st.
1. East Side	In Albany st., from E. Chester park to Dover st.
1. Stony Brook . . .	In Tremont and Cabot sts., from Camden st. to Ruggles st.
2. Stony Brook . . .	In Cabot, Hampshire, Elmwood, Ruggles and Tremont sts., about Stony Brook
1. South Boston . . .	In Ninth st., from H st. to N st.
3. South Boston . . .	In Von Hillern st., Locust st., Washington ave., and Hyde st., from Mt. Vernon st. to Dorchester ave.
4. South Boston . . .	In Dorchester ave., from Hyde st. to B st.
Pumping-station .	Connecting Main Sewer with Filth-Hoist and Engine Wells
2. Outfall Sewer . .	Tunnel under Dorchester Bay, from O. H. Pier to Squantum Neck (excavation)
3. Outfall Sewer . .	Squantum Neck to Moon Island
Totals	

IMPROVED SEWERAGE CONSTRUCTION.

Size in feet and inches.	Length in feet.	Built prior to Jan. 1, 1880.	Built Jan. 1, 1881.	Built by
7 ft. 8 in.	1675.5	1675.5	1675.5	P. J. Condon.
8 ft. 5 in.	1390.5	1390.5	1390.5	P. J. Condon.
8 ft. 5 in.	1795.	1795.	1795.	John Cavanagh.
9 ft.	2304.5	1200.	2321.	Charles Linehan.
9 ft.	1894.	489.	1894.	City.
{ 9 ft. } { 10 ft. 6 in. }	3381.	2720.	3381.	Hoblitzell, Condon, and Hoblitzell, and City.
10 ft. 6 in.	4088.	4088.	4088.	Clinton Beckwith, and J. V. Quackenbush.
4 ft. 9 in. \times 5 ft. 6 in. . .	4282.	4282.	4282.	City.
{ 4 ft. 9 in. \times 5 ft. 6 in. } { 4 ft. \times 4 ft. 6 in. . . }	5043.	4923.	4923.	City.
4 ft. \times 4 ft. 6 in.	1832.	1832.	1832.	Thos. McCann.
5 ft. 8 in.	4524.5	4524.5	4524.5	A. H. Delamater & Co. and R. A. Malone.
4 ft. 8 in.	2135.	2135.	2135.	Myles Tierney.
{ 4 ft. 6 in. } { 2 ft. \times 3 ft. }	3770.	. . . .	2200.	City.
3 ft. 2 in.	2717.5	2717.5	2717.5	Stephen Connelly & Co. and City.
{ 6 ft. } { 4 ft. 9 in. \times 5 ft. 6 in. } { 4 ft. 6 in. \times 3 ft. . . . }	3739.	2430.	3739.	Charles Linehan.
4 ft. 9 in. \times 5 ft. 6 in. . .	3350.	2400.	3350.	Hoblitzell, Condon, and Hoblitzell, and City.
{ 10 ft. 6 in. } { 9 ft. }	332.	. . . .	332.	City.
7 ft. 6 in.	7011.	75.	2398.	R. A. Malone.
11 ft. \times 12 ft.	5989.	. . . .	200.	W. C. Poland & Son.
	61453.5	38677.	49178.	

SECTION 4, MAIN SEWER.

1,121 feet of this sewer, 9 feet in diameter, were built during the year. For nearly the whole distance a simple 12-inch ring of brick-work, founded on the clay, proved to be sufficiently stable. In passing the large gas-holder of the Boston Gas-Light Company a leak into the trench, from the well of the holder, caused some apprehension, but was stopped before causing damage. As a precaution, in passing within 35 feet of the holder of the Roxbury Gas Company, 4-inch, tongued and grooved, sheet planks were driven, and the trench back-filled, to the crown of the sewer arch, with concrete. No especial obstacles were encountered until the site of the old Roxbury canal, recently filled by the city, was reached. Here an influx of tide-water, along the loose walls of the canal, occasioned much trouble and delay. The sheet planks were backed with clay without success, and the walls had finally to be cut off by several dams, made of double rows of planking, filled with puddled clay. The contractor spent five months in contending with these difficulties, and, just as they seemed to be surmounted, the inclemency of the season obliged him to suspend operations for the winter. About 180 feet remain to be built, and it is hoped that this work can be accomplished early in the spring; thus completing the last gap in the main sewer, from its beginning at Huntington avenue to its end at old Harbor Point. A side-entrance and boat-chamber have been built on this section, at the corner of East Chester Park and Swett street, to afford convenient facilities for visiting the sewer.

SECTION 4½, MAIN SEWER.

This section, work on which began August 1, 1879, was completed in October, 1880. It was built by the city, under the superintendence of Mr. H. A. Carson, and the method of its construction was described in last year's report. It was designed to withstand slight movements, and, as none of moment have been noticed in the filling which surrounds it, is believed to maintain its shape and grade.

SECTION 5, MAIN SEWER.

On this section work progressed slowly during the year. No difficulties were encountered in building the sewer at either end of the section, where it was in open cut, although expensive precautions were required in passing under the Old Colony Railroad tracks. About 1,900 feet of the middle of the section were built by tunnelling through conglomerate rock and coarse sand. The rock, where it surrounded the tunnel, presented no serious obstacle; but the sand tended to run into the excavation, and required close sheeting and heavy bracing to support it. For several hundred feet the sewer grade was near the surface of the ledge, and the latter, being very irregular and covered with boulders, tunnelling operations at this point were attended with considerable difficulty; several caves occurred, and the rate of progress was very slow. For a length of 160 feet the ground was opened from the top, and the sewer built in a trench about 45 feet deep.

Finally, on October 25, 1880, the contractors, having become financially embarrassed, notified the committee of their inability to complete the work, and definitely abandoned it. The city at once took possession, and completed the short distance that remained. Although the tunnel had been well built, for that class of masonry, it was found to leak considerably in places, after the pumps had been removed from their wells, and the water-table rose above the sewer. These leaks, however, could be successfully calked. The process consisted in raking out a joint,

where a leak occurred, to the full depth of the brick, and driving in sheet lead for half the depth, the remainder being filled with cement.

The whole section is now complete, except a little more calking, and the building of the upper portion of one manhole.

SECTION 6, MAIN SEWER.

Although the whole of this sewer was built prior to 1880, it was found, as stated in the last report, that for about 150 feet of it the side-walls had spread somewhat, and the crown flattened, necessitating repairs. Although even this portion was probably stable, it was not considered wise to establish a precedent of accepting any imperfect work. The contractor was accordingly directed, January 30, 1880, to reconstruct the sewer arch at this point, and, on his declining to do so, the work was relet, under provisions of the contract, to J. V. Quackenbush. The trench was reopened, the sewer uncovered, and its arch broken down with sledges. It was found that the 12-inch Akron pipe, extending under the sewer, to facilitate drainage during construction, was broken at this point, and the water from it, accumulated from 4,000 feet of trench, found an outlet and poured over the side of the invert. This water was controlled by pumps, but was found to have washed out a quantity of sand, causing a considerable cavity under the sewer platform. Five holes, 10 feet apart on centres, were made through the bottom of the sewer, and 3-inch wrought-iron gas-pipes inserted in them. Two of these pipes were about 30 feet long, and three others, for vents, were 5 feet long. Constant streams of grout, made from 47 casks of neat, quick-setting, Portland cement, were forced under a 25-feet head, through the long pipes into the cavity, till it was filled, as shown by the cement rising in the short pipes. The grout hardened satisfactorily, and furnished a secure foundation. Special ribs were cut to fit the invert, which was again covered. The section, thus completed, is in good condition.

SECTION 3, SOUTH BOSTON INTERCEPTING SEWER.

This section was completed in December, 1880. No especial difficulties were encountered in building it, and the work is, on the whole, satisfactory. A regulating chamber, similar to that shown on the plan, is placed in the line of the sewer, near Kemp street, to control the amount of rain from the whole of South Boston to be admitted to the main sewer. An iron flushing-gate is also provided for this section, and where the north and south branches of the South Boston sewer come together they unite in a bell-mouth connection-chamber.

SECTION 4, SOUTH BOSTON INTERCEPTING SEWER.

Nothing worthy of note occurred in building this section until October 25, 1880, when the contractors, the same as for Section 5, main sewer, abandoned the work. The city at once assumed control, and appointed Mr. C. F. Gilman superintendent, under whom the sewer was completed. The amount of water met with occasioned some difficulty, but sound work was obtained. An iron flushing-gate is included among the appurtenances to this section.

SECTION 2, STONY BROOK INTERCEPTING SEWER.

Work on this section was begun early in June, 1880. It is built by the city, with Mr. H. A. Carson as superintendent. The section consists of several branches, radiating from the upper end of Section 1, at the corner of Cabot and Ruggles streets, and is intended to intercept the

whole of the sewage now discharging through various outlets into Stony Brook. The main branch, $4\frac{1}{2}$ feet in diameter, mainly in Hampshire street, is about 1,700 feet long, and takes the sewage entering the brook through the Elmwood and Hampshire street outlets. It passes twice under the brook, low enough to preserve its regular grade and shape. The other branches are built just large enough to enter conveniently, being 2 by 3 feet, egg-shaped, with the smaller end down. Two of these also cross under the brook, at Tremont street and at Ruggles street.

All the branches unite in a three-way bell-mouth chamber, whence the sewage will pass through the regulating chamber shown in the plan. As will be seen, the apparatus is very simple, and consists of stop-planks, closing the sewer from its top down to about the ordinary flow line, the sewer below the planks being lined with a cast-iron gate-frame or seat, curved to fit the invert, and also vertically to correspond with the plane of motion of the cast-iron gate which plays up and down in front of it. The gate is held by 2 cast-iron arms, pivoted by a 3-inch wrought-iron shaft in 2 bearings, and connected by vertical arms at their ends to a 3-inch square bar. To the ends of this bar are connected two boiler-plate floats, placed in wells on either side of the sewer. To avoid disturbance to the motion of the floats by waves, caused by the rush of sewage under the gate, water is brought to the wells through a 5-inch pipe, as shown, from a point 50 feet below the gate.

The city sewers are connected with the intercepting sewers by short branches, from 12 to 24 inches in diameter, starting from sump-holes in the former. Into these sump-holes the amount of sewage to be taken will fall, and over them will flow the excess of rain to be wasted. The immediate inlet, at the bottom of the sump, consists of a short section of iron pipe, with an iron flap valve hinged over it, the latter being closed if there is need of emptying the collector.

As the city sewers, intercepted by this section, although below the level of high-water, are not provided with tide-gates, it will be necessary to provide a double set for each.

PUMPING-STATION SEWERS.

These comprise 97 feet of $10\frac{1}{2}$ -feet sewer, extending from the end of Section 6. main sewer, to the filth-hoist, and a pair of 9-feet sewers, 235 feet long in all, leading from the same structure to the galleries connected with the pump-wells on either side of the engine-house. They were built by Mr. S. H. Tarbell, superintendent for the city. A salt-water well, and the beginning of a $5\frac{1}{2}$ -feet sewer from it, have also been constructed at this point, for the purpose of bringing sea-water to the pumps, should a sufficient quantity of sewage not be supplied by the main sewer.

PUMPING-STATION AND FILTH-HOIST.

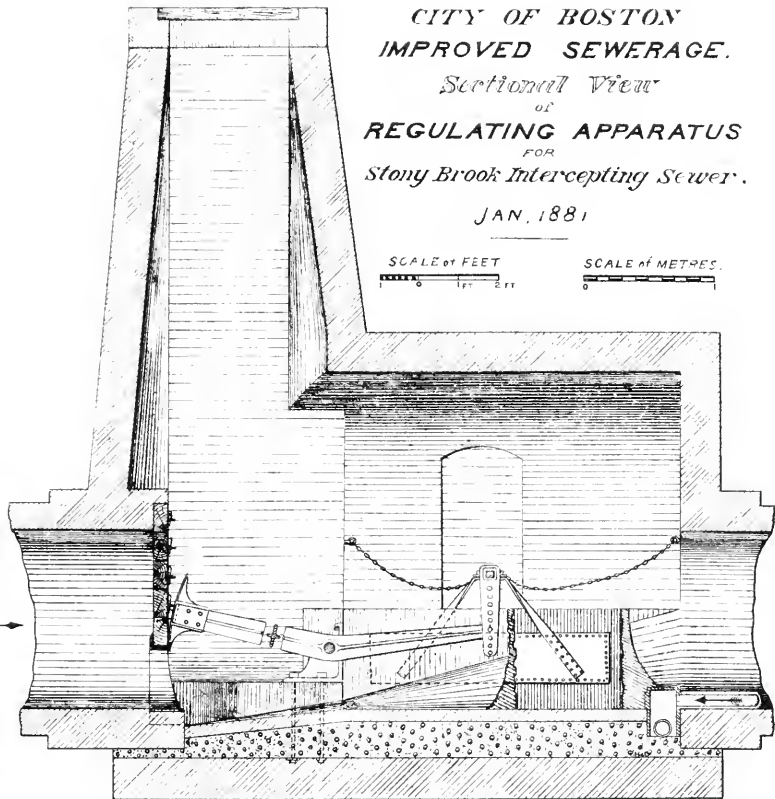
The filth-hoist has been completed to grade 16, except setting the cages, machinery, and some other iron-work. The sewers, where they connect with it, have granite voussoirs cut to form bell-shaped groins. The 4 gate-openings are formed of large granite blocks, faced with 6-cut work. The outside walls are of granite, and the division walls of brick. The depth of the structure below the surface of the ground is about 30 feet.

The foundation walls of the engine-house are also completed to grade 16.5. These walls, aggregating about 340 feet in length, are 37.5 feet high, and 9 feet thick at the bottom, where they rest on 24 inches of timber platform. They are built of granite, and although called rubble

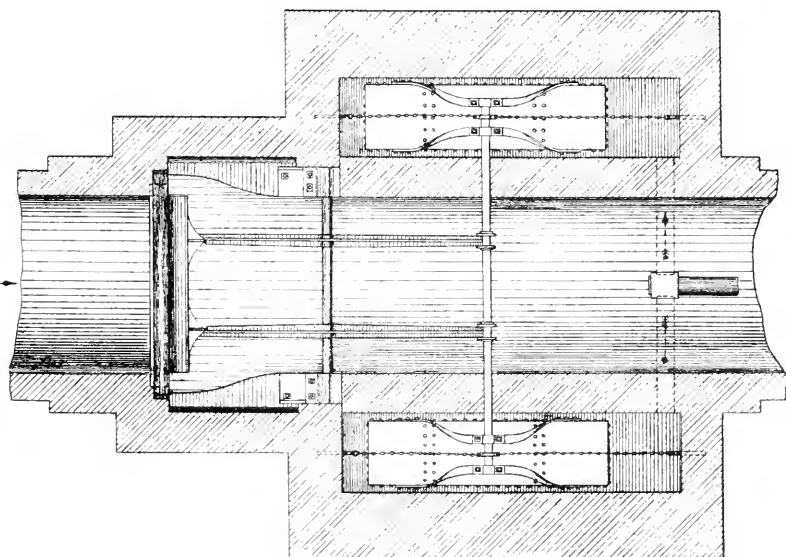
CITY OF BOSTON
IMPROVED SEWERAGE.
Sectional View
of
REGULATING APPARATUS
FOR
Stony Brook Intercepting Sewer.
JAN. 1881

SCALE of FEET
1 0 1 FT 2 FT

SCALE of METRES.
0 1 2



SECTIONAL ELEVATION



SECTIONAL PLAN

masonry, yet, owing to the sizes and shapes of the stones used, and the care taken in selecting and laying them, resemble more nearly a fair quality of roughly coursed block-stone work. Two of the engine piers are wholly, and 2 others partially, completed, including the setting of cut-stones and iron-work imbedded in the masonry. 213 cut-stones, besides those dressed on the ground, were furnished by the Cape Ann Granite Co., under a contract dated March, 1880. The same company also furnished 70 stones for the filth-hoist.

Considerable delay in building the engine piers was occasioned by an uncertainty as to the character of 2 of the engines which were to rest on them. This doubt having been removed, the work will be pushed rapidly to completion. A portion of the site of the engine-house has been roofed in to permit the laying of masonry during the winter.

In May, 1880, a contract for 4,000,000 bricks, to be used in constructing the engine foundations and Dorchester Bay Tunnel, was concluded with Messrs. Stoddard & Hellier, of Bangor, Me., and over 2,000,000 of them have been already delivered, and are housed under a temporary wooden structure. Various offices, store-houses, cement and tool-sheds and workshops have been built in the vicinity of the engine-house. The foundations for the boiler-house are also completed.

A large portion of the 2 pumping-engines, ordered from the Quintard Iron Works, of New York, has already been delivered, and is on the ground. It is cared for by the contractors, by whom the engines are also to be erected.

SECTION 1, OUTFALL SEWER.

As a preliminary to building this section, which consists of an elevated double sewer, extending about 1,200 feet, from near the engine-house, out to the west tunnel-shaft, it was necessary to construct a pier to support the sewers. The work of building this pier, called Old Harbor pier, was awarded by contract, March 8, 1880, to Messrs. Edwards, Derry, G. H. Cavanagh, J. Cavanagh, and Sylvester. The work covered by the contract consists of a gravel pier about 1,200 feet long, protected on its sea side by a riprap embankment, ballasted with broken stones and oyster-shells, and on its landward slope by layers of ballast and riprap, and terminated at its easterly end beyond the shaft by a sea-wall of cut-stone masonry, resting on a pile foundation.

In the riprap embankment there has been placed 27,096 tons of large stones, and 6,579 yards of ballast, and it is nearly finished: 80,219 yards of gravel filling are in place. The gravel has been obtained by dredging, and is dumped from scows near the end of the pier, whence it is raised and placed in cars by a dipper-dredge, a small engine hauling the cars to the proper places for dumping. A portion of the piles for the sea-wall foundation are driven, and the stones for the wall itself are cut and on the ground.

This work was stopped, on account of ice in the bay, Jan. 7, 1881, but will be renewed as soon as the season permits.

SECTION 2, OUTFALL SEWER.

On this section, commonly called Dorchester Bay Tunnel, some difficulties incidental to such work have been encountered, but none of a serious nature, nor any that might not have been anticipated. On the whole it may be said that the developments are quite as favorable as were expected when the work was decided on. At the beginning of last year the contractor, Mr. Malone, was engaged in sinking two of the three shafts, and the third was begun soon after. At the east and middle shafts the iron cylinders, which form their upper portions, were forced down to the rock at depths below the surface of the ground, of 21 and

38 feet respectively. These shafts were continued in the rock, to and below the grade line of the tunnel, which is established about 142 feet below the elevation of city base or mean low water. Excavating for the tunnel, from these shafts, has progressed steadily, with two short interruptions, and, at these points, nearly 2,000 linear feet are now ready to receive the brick lining.

From the end of the inclined portion of tunnel, situated midway across Squantum neck, a heading was driven downwards for about 400 feet and then stopped, owing to the difficulty and expense of removing the water which accumulated at its face. The remainder of the incline will be completed from the east shaft, and less than 100 feet of it remain to be excavated. The rock met, thus far, has consisted almost entirely of slate, of different degrees of hardness, penetrated with planes of bedding and cleavage, which renders it easy to work. Contrary to expectation, very few layers of conglomerate have been found, which fact is favorable to the rapid prosecution of the work. The rock yields no more water than was to be expected, the maximum quantity to be disposed of at present, at any shaft, being about 12,000 gallons an hour. Pumping machinery of insufficient capacity, provided at the outset, caused some delay. At the east shaft a failure of the pumps, Aug. 20, 1880, allowed the drifts and shaft to fill with water, which, after several trials, was pumped out again and controlled October 21. Work at the middle shaft was stopped about Aug. 20, until a new and larger pump could be obtained; but the water was kept down in the interval.

At the west shaft it was not expected that the cylinder could be driven to the rock. By weighting it with about 180 tons of iron dross, it was finally forced down into the clay to a depth of about 60 feet below the surface of the ground. Below this point a square shaft was excavated, with great ease, in plastic clay, penetrated with occasional veins of fine sand, but yielding little water, and was rather hastily timbered. Just above the rock was encountered a bed of gravel and hard-pan, bringing water at the rate of about 10,000 gallons an hour. At this time movements were observed in the lining of the shaft, and the timbers, on one side, near its bottom, bulged in. It was not considered safe to allow the shaft to remain in this condition, and about 40 feet of it were retimbered, the old sticks being cut out with chisels. This work was accomplished, but not without great difficulty. Although the quantity of water was not great, the cramped dimensions of the shaft afforded little room for the pumps, or opportunity for supporting them. To counteract a downward pressure exerted by the clay upon the lower part of the shaft-lining, a portion of it was suspended from the cylinder above by iron bars, and, on these breaking, by heavy wire cables. After the shaft had been retimbered, it was sunk to grade through the rock, and 14 feet of tunnel excavated. At this time, August 3, 1880, a failure of the pumps allowed the shaft to fill before they could be removed. It was pumped out again on Nov. 9 and 22, by means of a special, upright, sinking-pump, suspended from above, and, although maintained on each occasion for a short time, was finally lost through some failure of the pump. Nothing further was done at this point till January 17, 1881, when the shaft was again cleared of water, a new pump set in position, and the work of excavation resumed.

In giving lines for the tunnel, instruments designed by the engineers are used, by means of which a beam of light from the heading is reflected from the bottom of the shaft to a transit at its top.

Three casualties, resulting in death, have occurred in connection with the work; but in no case, as is believed, through negligence on the part of the contractor. One man fell down the middle shaft; another was crushed by a car falling on him; and a third, not employed by the contractor, was killed while unloading coal.

In detail, the tunnel excavation, completed Jan. 1, 1881, is as follows:

From west shaft eastward	14 feet
" middle shaft westward	533 "
" " " eastward	546 "
" east " westward	494 "
" " " eastward	417 "
" " portal westward	394 "
Total	<hr/> 2,398 feet

SECTION 3, OUTFALL SEWER AND MOON ISLAND RESERVOIR.

The contract for constructing this section was awarded, April 20, 1880, to William C. Poland & Son, of Boston. The contractors began about May 1 the preliminary work of constructing offices, sheds, barns, and a wharf, and on May 17th the building of the embankment for the sewer was commenced. A portion of this embankment, which extends opposite the reservoir and from Moon Island to Squantum, has been raised to grade 16, and the whole of it is as high as grade 6. Parts of it are also ballasted and riprapped.

The lower portion of the embankment is formed of dredged material; the upper of gravel dug from or near the reservoir site. The gravel has been moved by carts; but the haul being now too long to make this economical, the contractor has built a pile trestle the whole length of the embankment, and intends to use steam power in the future. In all, nearly 150,000 cubic yards of material have been put into the embankment, of which 54,000 were excavated from the site of the reservoir.

Two hundred linear feet of the sewer have been constructed at its westerly end, on Squantum neck.

For a short time during the last summer some annoyance was experienced in prosecuting the work on this section through an attempt by outside parties to prevent access to the work by closing all approaches to it. The city employes were obliged to remove barriers erected against them, and, an injunction restraining them from maintaining a free passage having been refused by the Supreme Court, no further trouble was experienced. As a precaution, however, a right of way from a public road to the sewer line was taken by the city, under the act authorizing the construction of the works.

Work on this section ceased Dec. 28, on account of the inclemency of the season, but, it is hoped, will be soon resumed.

OFFICE AND OTHER WORK.

In addition to the above, in compliance with the terms under which the city obtained the right of way for building Section 3, South Boston Intercepting Sewer, a road-way has been graded over Hyde street, Washington avenue, and Von Hillern street. A contract for doing this was awarded, Feb. 28, 1880, to Charles Linehan. The gravel filling is brought by the Old Colony Railroad Company from a bank at Quincy, where it is measured by the city. About 22,000 cubic yards have been already delivered, and the work is nearly completed.

To provide an approach for colliers and other vessels, from the ship channel in Dorchester Bay to the city's wharf at Old Harbor Point, a contract was concluded, April 20, 1880, with the Old Harbor Pier Company, for dredging a navigable channel, about 2,200 feet long, 12 feet deep at low water, and about 100 feet wide on top. 69,000 yards of material have been already removed, which comprises the bulk of the work contemplated.

Early in January, 1880, Mr. Malone, the contractor for Dorchester Bay Tunnel, desired, in order to facilitate his work on the tunnel, to ex-

cavate the open cut for Section 3, Outfall Sewer, on Squantum neck, adjoining the east portal of the tunnel.

As his terms offered were favorable, being one dollar a yard for rock excavation, and twenty-five cents a yard for earth, a contract with him was signed Jan. 18, 1880, and the trench, for its length of 600 feet, is now excavated to its proper size and grade.

The engineering force has been employed, as in previous years, in making surveys, giving lines and grades, making calculations, measurements, and estimates, and in superintending construction. All contract work has been constantly watched by competent inspectors, and force accounts have been kept of all labor employed.

The difficulty of reaching portions of the work from the city led, in May, 1880, to the establishment of an engineering party, under Mr. F. P. Stearns, at Squantum, where an office was hired for them. This party takes charge of Dorchester Bay Tunnel and Section 3, Outfall Sewer and Moon Island Reservoir.

Several hundred light rod borings have been made during the year, principally in the vicinity of Moon Island.

A supplementary series of float experiments were made, at different stages of the tide, from Moon Island, and their result confirmed the previous decision as to the proper place for the sewer outlet.

The testing of cement bought by the city or by contractors has constituted, as heretofore, an important, if minor department of office-work. During the year 8,575 tests in all have been made, including 2,700 for experimental purposes. The best result of this rigid testing of cement is that little of inferior quality is now offered. Of 17,906 casks examined last year, but 516 were rejected.

From one to three draughtsmen have been constantly employed in the office, making record and working plans, and a clerk is employed to keep a set of account-books, and to perform other incidental office duties.

E. — PARKS.

The report of the Park Commissioners (City Doc. No. 12, 1881) gives a general statement of work now in progress on the Back-Bay park; but as a more particular statement and description of the portions of it under the supervision of this department may be of value for future reference, the following synopsis is given: —

GENERAL WORK, FILLING, ETC.

In January a new channel for Muddy river was excavated through the marsh near the easterly side of the park. This channel, together with the culvert previously built through the road-way across Muddy river, near the Huntington entrance, provided for the flow of water in both Muddy river and the old channel of Stony Brook, so that it was possible to continue the construction of the boundary road between Huntington and Parker Hill entrances without injury to private parties. The filling by carts was continued on this road during the winter and early spring, under direction of the superintendent appointed by the Park Commissioners. The Health Department was allowed to dump

ashes, etc., within the park limits, until about the first of July.

The contract for filling the roadway on the westerly side of the park, made with the Boston and Albany Railroad Company June 20, 1879, was continued in force by a supplementary contract, dated January 28, 1880, which provided for the filling of the site for the Boylston-street bridge over the park water-way. The price paid for the additional filling was \$3.25 per square.

The extended contract was completed March 29, 1880, the total amount deposited being 24,176 squares, at \$3.45, and 5,800 squares, at \$3.25. The total number of car-loads was 70,425. The gravel was brought from the company's bank at Weston, about 10 miles from the park.

June 1, 1880, a contract was made with the Boston and Albany Railroad Company, for the filling of the boundary road from the point near Longwood entrance, to which it was filled under the previous contract, to the Huntington entrance. This work was begun July 1, and is now nearly completed; 30,981 car-loads of gravel have been delivered under this contract, amounting to 12,197 squares. The contract price is \$3.45 per square.

November 4, 1880, a supplementary contract was made to provide for the filling of the portion of the park roadway between the Huntington entrance and Boylston street. The price to be paid is \$3.20 per square.

Huntington entrance has been partially filled with surplus earth from the Sewer-Department excavations on the improvement of the channel of Stony Brook, and also with surplus earth from the excavations on the Improved Sewerage system, on Hampshire and Ruggles streets. The number of cart-loads deposited by the Sewer Department, to December 31, was 21,702, and by the Improved Sewerage Department, 2,370. These quantities are the net amounts left after the deduction of the loads which were exchanged for sand. For an account of the filling of the Beacon entrance see "Commonwealth-Avenue Extension."

Tallymen are employed, who keep an account of the number of cars removed from the different gravel-banks for the contract work, and also the number delivered on the work.

BOYLSTON-STREET ARCH BRIDGE.

At a distance of about 300 feet southwardly from the Boston and Albany Railroad the park pond is to be crossed by an elliptical arch bridge, which is on the extension of Boylston street, through the park. The water-way is nar-

rowed at this point to a width of 60 feet, and the arch which spans it is intended by Mr. Olmsted, the landscape, and Mr. Richardson, the consulting, architect of the Park Commissioners, to be the most prominent feature of the park.

The bridge is to have a width at the westerly end of about 141 feet, and at the easterly end of about 111 feet. The arch which forms the bridge will be straight at the southerly end and askew at the northerly end. The span is to be 60 feet at right angles to the water-way, but at the skew end the span at the face of the arch is 67 feet; the rise is to be 18 feet, measured from the water line or grade 8. The abutments, spandrel walls, and faces of the arch will be granite; the intermediate portions will be brick.

A contract for building the foundations and abutments for the arch was made, Sept. 28, 1880, with Mr. Isaac A. Sylvester, of Newton, the contract price being \$38,647. Before the plans and specifications for the work were completed a careful examination, by means of soundings and borings, was made of the materials composing the substrata at the point of location.

The result of this examination, which was supplemented by driving trial piles, while it indicated unmistakably the practicability of and necessity for a pile and platform foundation for the westerly abutment, was not so positive with regard to the foundation for the easterly abutment. The substratum into which the piles will have to be driven for the easterly abutment is a very compact sand, and, as the number of piles required is very large, it was thought somewhat doubtful if they could be driven into the material; provision has therefore been made in the contract for substituting a foundation of hydraulic cement concrete.

The foundation for the east abutment is to consist of rows of spruce piles, $2\frac{1}{2}$ feet apart, each row capped with 10×12 inches hard-pine timber, with the spaces between the caps and around the heads of the piles filled to a depth of 2 feet with hydraulic cement concrete. A flooring of spruce timbers, 6 inches in thickness, is to cover the caps, and form the platform from which the masonry is to start. The masonry for each abutment will be 16 feet in width at the bottom, and 6 feet 6 inches in width at the top, and will consist of 5 courses of cut stones, with inclined beds and builds, except the beds of the lowest course, which will be horizontal. The arch practically commences at the platform; but the masonry now under contract will not be seen above the usual water-line, and has therefore been considered, for convenience of description, as forming abutments.

The season was so far advanced at the time the contract

was closed, that not much progress has been made in construction. The coffer-dam to enclose the foundations is, however, nearly completed; 7,000 cubic yards of excavation have been made, and 236 cubic yards of cut stone delivered. The work will be actively prosecuted as soon as the season opens, and it is hoped will be completed in time to commence the arch by the middle of the year.

COVERED CHANNEL OF STONY BROOK.

Under this head is included a covered conduit extending from Charles river across Beacon street, and through the 50-foot street on the easterly side of the Beacon entrance, to the roadway on the southerly side of the railroad, thence following the roadway to a gate-chamber situated on the border of the Park pond, nearly opposite to the Huntington entrance. The gate-chamber is to form the connection between the conduit, the Park pond, and the extension of the present Stony-Brook channel, now terminating at Parker street.

The extension of the Stony-Brook channel to the gate-chamber will consist of two arched water-ways of practically the same section as the ones with which they are to connect.

The conduit from Charles river to the gate-chamber is 3,520 feet long, and 7 feet 2 inches internal diameter. It is built of spruce planks, 2 inches in thickness and 8 inches in width, thoroughly trenailed together, and every fourth plank is wedge-shaped, to give the conduit its circular form. About 1,700 feet of it are now completed. If deemed advisable, after completion it can be lined with an inch of concrete, as it is 2 inches larger in diameter than at first contemplated.

The gate-chamber substructure will be built of rubble granite, with brick inverts, and of cut-stone for all gate-openings and for a portion of the flooring.

Plans and sections of this structure are shown on the accompanying plates, which also show the dimensions of the water-ways forming the extension to Parker street.

These water-ways are 324 feet long, and will have stone side walls with brick arches and linings laid in cement, the whole structure having a pile platform foundation.

All of the work upon these structures is being done by day's labor, under the immediate supervision of Mr. Howard A. Carson. The machinery invented by him is used for making the excavations, and proves both efficient and economical. The right to use this machinery in all the city departments was purchased July 28, 1880.

In addition to the part of the conduit which has been constructed, the excavation for the gate-chamber and a large portion of that for the water-ways between the gate-chamber and Parker street, has been done. The pile foundation and timber platform for the gate-chamber is also completed, and a contract has been made with the Cape Ann Granite Co. for the stone for the substructure. The appropriation for the entire work is \$110,000, and the amount expended to January 1, 1881, was \$33,199.43.

The flow of water into the pond and the regulation of its height are controlled by the gates in the chamber, in connection with the dam to be built in the Beacon-street bridge water-way. (See description of this dam, page 18.)

The gate-chamber, the conduit, the pond, and the dam at Beacon street, must be considered together to understand the manner in which the waters of Stony Brook are to be controlled and disposed of. The gate-chamber is furnished, as shown on the plan, with double water-ways; corresponding to the water-ways of Stony Brook as they now exist. These water-ways are each provided with a double set of self-acting gates, which prevent the water from the pond from running into the conduit, and thus finding its way to Charles river. These gates serve, also, to admit into the pond whatever portion of the water from Stony Brook the conduit is not capable of discharging into Charles river in time of freshets.

The conduit will convey the ordinary flow of the brook to the river, and will also at every high tide be full of salt water from Charles-river basin as far as the tide-gates in the chamber near its connection. This salt water can be let into the pond, if it is desired, through a gate in the chamber provided for the purpose.

If the water in the pond, which it is proposed to maintain generally at grade 8, reaches a higher grade, by reason of the discharge into it of the waters of Stony Brook in time of freshets, the surplus water (unless the tide should be at a still higher level at the same time) will be discharged over the dam at the Beacon-street water-ways, and this discharge will continue as long as the level of the pond is above the dam and the height of the tide below grade 8.

The table, showing the width of draw-openings in the bridges over tide-water in this city, is given in the Appendix. The openings have all been remeasured for this report.

In closing this my first annual report to the City Council, I should state, for the information of such of its members as were not in office last year, that I succeeded Mr. Joseph P. Davis, upon his resignation of the office of City Engineer, March 20, 1880, and appointed to fill the vacancy caused by my promotion from Chief Assistant, Mr. Alphonse Fteley, formerly the resident engineer in the building of the Sudbury-river works.

Nearly all of the works described in the foregoing report, especially under the heads of "Additional Supply," "Improved Sewerage," and "Parks," had already been studied, designed, or nearly completed, under the direction of my predecessor; and if those which are now incomplete, prove, as I have perfect confidence they will, as successful engineering works as those already completed, they will be monuments which will attest his skill and eminence in his profession.

HENRY M. WIGHTMAN,

City Engineer.

APPENDIX.

TABLE,

Showing the Widths of Openings for Vessels in all Bridges provided with Draws, in the City of Boston.

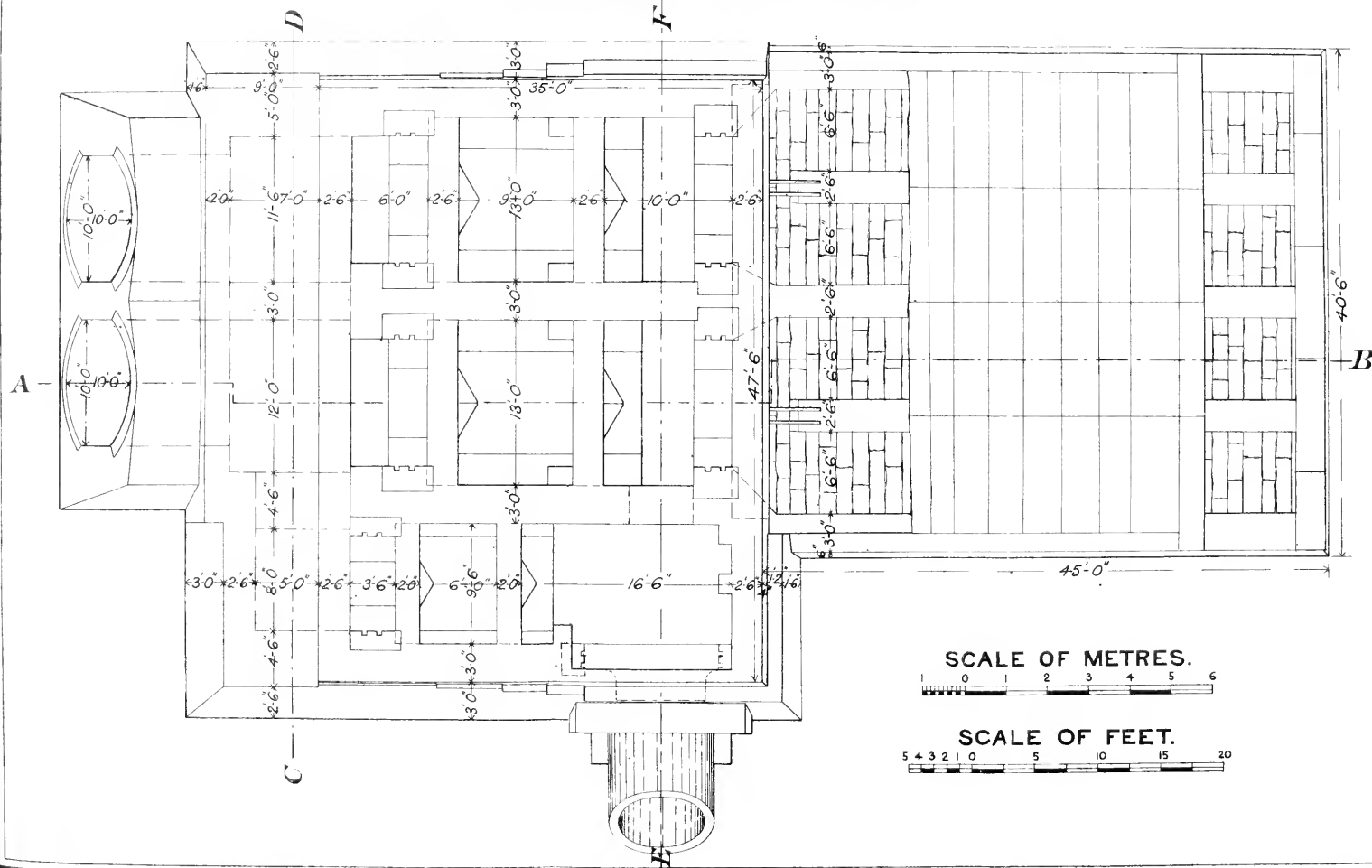
JANUARY, 1881.

NAME OF BRIDGE.	LOCATION.	NUMBER OF OPENINGS.	WIDTH.	
			Feet.	In.
Boston & Maine R.R.	Boston to Charlestown .	1	35	8
" "	Over Miller's river . . .	1	35	8
Broadway	Over Fort Point Channel	1	43	8
Cambridge st.	Ward 25 to Cambridge .	1	30	4
Canal	Boston to East Cambridge	1	35	9
Charles river	Boston to Charlestown .	1	35	7
Chelsea (South channel)	Charlestown to Chelsea .	1	38	8
" (North ")	" " " "	1	44	9
Chelsea st. (East Boston side) . .	East Boston to Chelsea .	2	32	11
" (Chelsea side)	" " " "		34	3
Commercial Point	Ward 24	1	24	4
Congress st. (Boston side) . . .	Over Fort Point Channel	2	43	3
" (South Boston side)	" " " "		43	3
Dover st.	" " " "	1	34	6
Eastern R.R.	Boston to Charlestown .	1	35	6

Eastern R.R.	.	.	.	.	.	.	.	Over Miller's river	1	35	5
Essex st.	.	.	.	.	.	.	.	Ward 25 to Cambridge	1	30	8
Federal st.	.	.	.	.	.	.	.	Over Fort Point Channel	1	35	4
Fitchburg R.R.	.	.	.	.	.	.	.	Boston to Charlestown	1	36	0
" " (for teaming freight)	.	.	.	.	.	.	.	" "	1	35	10
Grand Junction R.R.	.	.	.	.	.	.	.	Ward 25 to Cambridge	1	31	10
" "	.	.	.	.	.	.	.	East Boston to Chelsea	1	34	4
Granite	.	.	.	.	.	.	.	Ward 24 to Milton	1	30	10
Lowell R.R. (freight)	.	.	.	.	.	.	.	Boston to East Cambridge	1	35	4
" " (passenger)	.	.	.	.	.	.	.	" "	1	35	9
Malden	.	.	.	.	.	.	.	Charlestown to Everett	1	43	4
Meridian st. (East Boston side)	.	.	.	.	.	.	.	East Boston to Chelsea	2	58	9
" (Chelsea side)	.	.	.	.	.	.	.	" "		58	10
Mt. Washington ave. (Boston side)	.	.	.	.	.	.	.	Over Fort Point Channel	2	36	5
" (South Boston side)	.	.	.	.	.	.	.	" "		37	10
Neponset	.	.	.	.	.	.	.	Ward 24 to Quincy	1	31	1
New York & New England R.R. (Boston side)	.	.	.	.	.	.	.	Over Fort Point Channel	2	40	3
" " (So. Boston side)	.	.	.	.	.	.	.	" "		40	11
" "	.	.	.	.	.	.	.	Over South Bay	1	30	2
North Beacon st.	.	.	.	.	.	.	.	Ward 25 to Watertown	1	30	1
North Harvard st.	.	.	.	.	.	.	.	Ward 25 to Cambridge	1	31	5
Old Colony R.R.	.	.	.	.	.	.	.	Over Fort Point Channel	1	35	9
" "	.	.	.	.	.	.	.	Ward 24 to Quincy	1	36	0
Prison Point	.	.	.	.	.	.	.	Charlestown to Cambridge	1	35	3
Warren	.	.	.	.	.	.	.	Boston to Charlestown	1	35	8
West Boston (Boston side)	.	.	.	.	.	.	.	Boston to Cambridge	2	35	7
" (Cambridge side)	.	.	.	.	.	.	.	" "		35	11
Western ave.	.	.	.	.	.	.	.	Ward 25 to Cambridge	1	31	1
" "	.	.	.	.	.	.	.	Ward 25 to Watertown	1	29	5

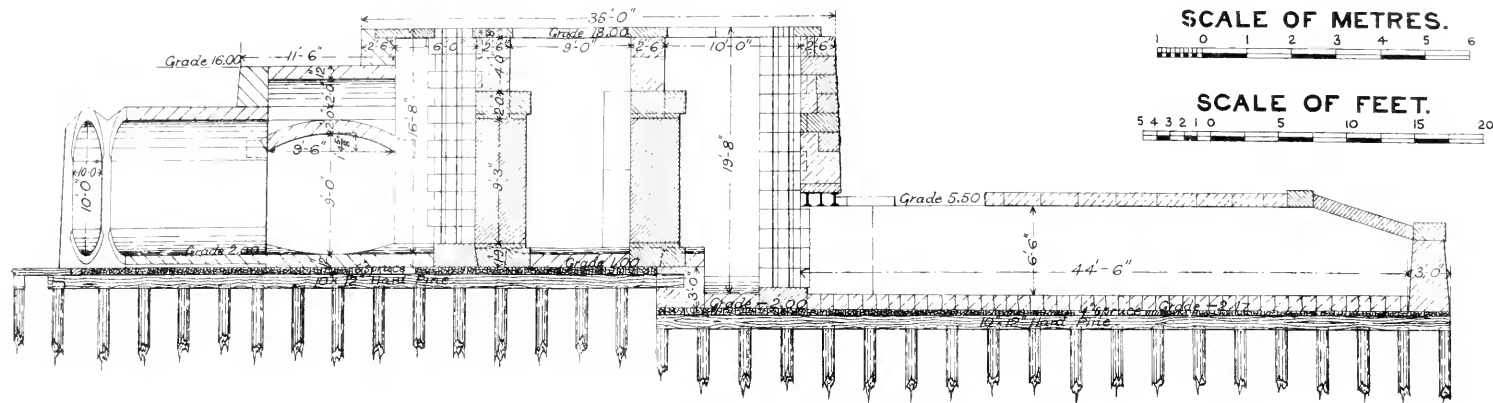
BACK BAY PARK-STONY BROOK GATE CHAMBER.

BOSTON JAN. 1881.

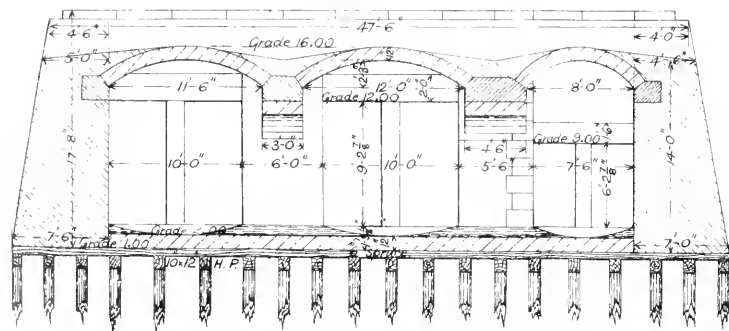


BACK BAY PARK-STONY BROOK GATE CHAMBER.

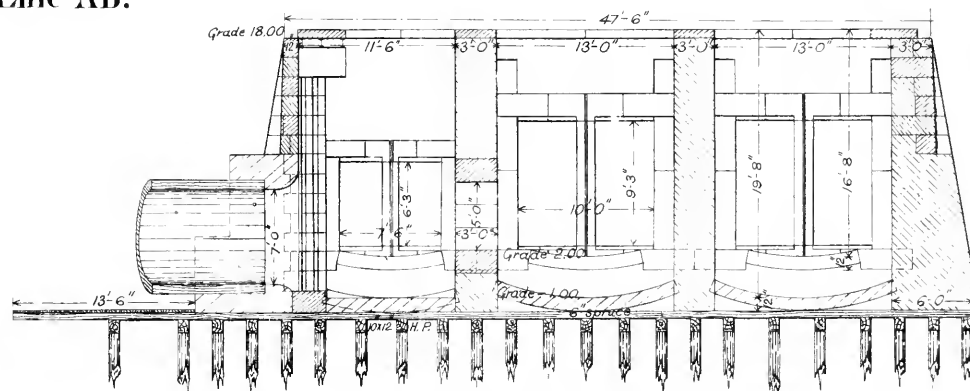
BOSTON JAN. 1881.



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